Fastener Information Booklet

Westbrand
INDUSTRIAL FASTENER SOLUTIONS

MORE THAN A SPECIALTY HOUSE

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Welcome

Welcome to the Westbrand Informational Booklet. Inside, we have compiled many relevant and useful charts, definitions, and fastener standards that we believe would be helpful to our customers.

The purpose of this book is to serve as a compilation of the many different facets of the Fastener industry compiled intoa singular location for your convenience. With insight into things as simple as abbreviations to the complexity of specifications.

While this book is to be used as a reference point, all information is intended for general reference only, and allfastener application decisions should be made after consulting experts with each specific standard.

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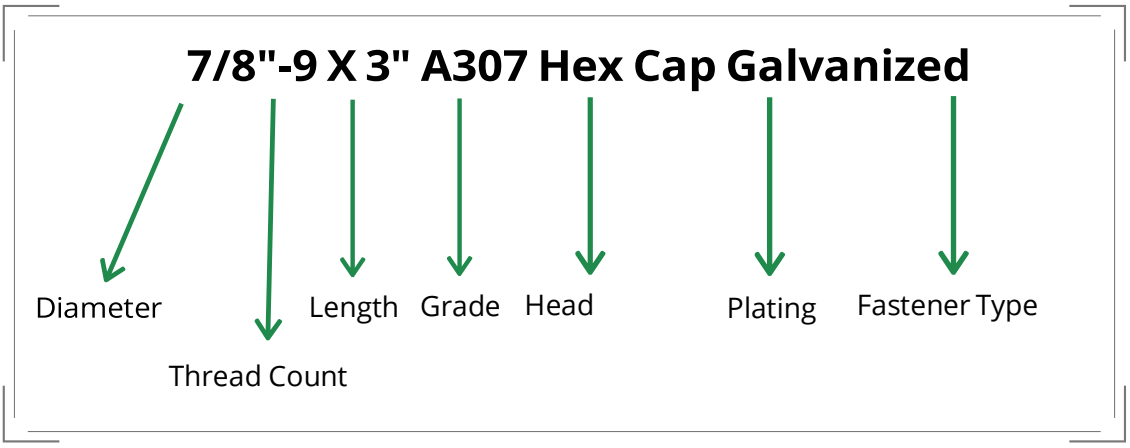
Basic Knowledge

Fastener Specifications

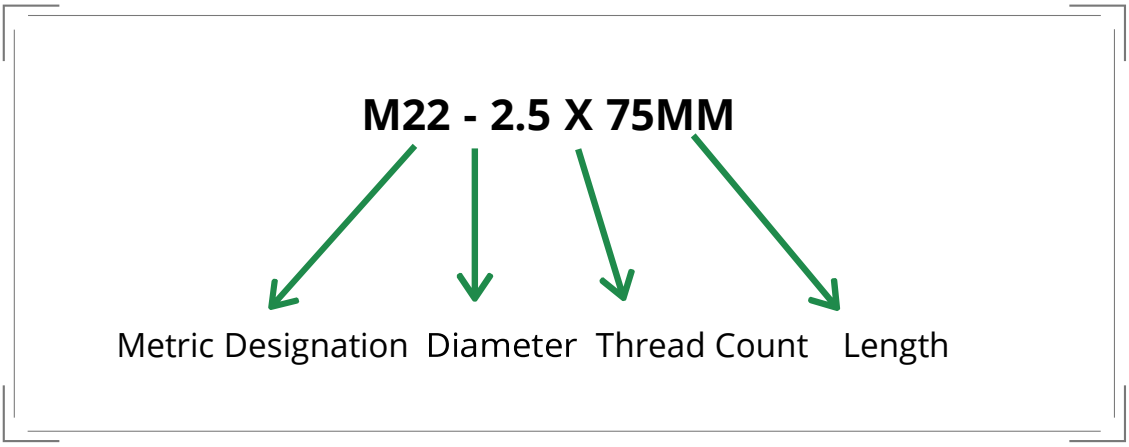
When writing specifications of a fastener it is important to maintain a rigid format that makes it easy for recipients of the specifications to know exactly what is required.

Below is a common way to write out fastener specifications:



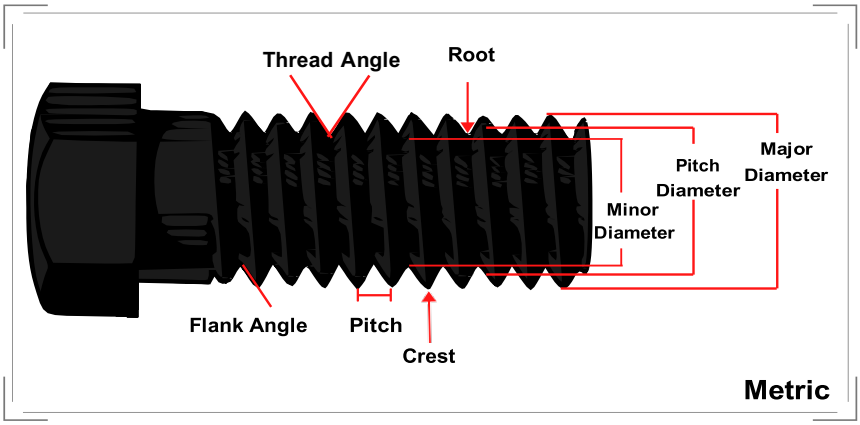
While the location of the head type, plating, and fastener type isn't a rigid format, it is essential that numericalindicators are written in this format.
Regardless of standard, the format goes: Diameter - Pitch - Length

An example of metric specifications in written form is seen below:

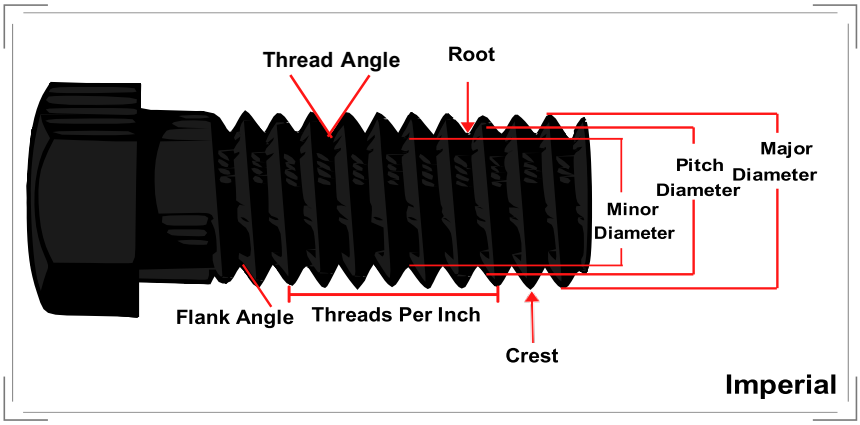


Threading Terminology

There are a variety of different terms that are used within the industry when defining specifics about threading. Below you'll find these specifics explained.



Crest	The prominent part of a thread.
Flank Angle	The part of the thread connects the crest and root, and the angle it sits at.
Major Diameter	The diameter of an imaginary cylinder that would just touch the crest of the threads.
Minor Diameter	The diameter of an imaginary cylinder that would just touch the root of the threads.
Pitch	The distance from one crest to another crest, measured across the threads. Pitch is usedwhen describing Metric fasteners.
Pitch Diameter	Refers to the width of the cylinder portion and at the midpoint of the major and minordiameters.
Root	Situated in the bottom of a groove, between two flanks.
Thread Angle	The angle of the slope between threads.
Thread Per Inch	Used to describe the number of threads there are within an inch on the fastener. Thisterminology is used with Imperial fasteners.



Basic Knowledge

Common Terms

Body	Refers to the part of a fastener that is smooth and located above the threaded portion. Often referred to as the shank.
Chamfered	To put an edge, or angle on something, that connect two separate surfaces.
Class	A term used for Metric fasteners. Designating the tensile strength a fastener can handle.
Clamp Load	Is measured as 75% of the proof load. This is to ensure that failure of the fastener doesn't occur.
Countersunk	Refers to the shape of a fasteners head type. Designed to rest flush with the object it is being inserted into.
Diameter	Types of diameter terms: • **Body Diameter** - Diameter of the smooth portion of a fastener located right above the threading. • **Major Diameter** - From the most external point of thread on one side, to the most external point of thread on the other side. • **Root Diameter** - From the internal point of thread on one side, to the internal point of thread on the other side. • **Shank Diameter** - Same as body diameter.
Die	A tool for cutting external threads into a rod or a bolt.
Engagement	Is the length a fastener is inserted into its nut member.
Ferrous Metal	Is a type of metal where the base material is iron.
Grade	Is a designation given to a fastener that lets the user know the tensile strength of the fastener.
Hardened	A heat treatment that is used to increase a fastener's strength.
Head Style	The top part of a fastener (Ex. Hex Head/ Square Head, etc.).
ksi	Kilo-pounds force per square inch.
Molybdenum	A chemical element often used in creating alloy metals.
MPa	Megapascal pressure unit.
Non-Ferrous Metal	Does not include iron in any discernible amount.
Pitch	Distance from one part of a fastener thread to the corresponding point on the next thread.
Proof Load	The maximum tensile force that can be applied to a fastener, without resulting in deformation.
psi	Pounds per square inch.
Shank	Refers to the part of a fastener that is smooth and located above the threaded portion.
Strain	Strain is the response to stress. Strain is defined as the length of deformation divided by the original length of the material.
Stress	Is used to describe the force that is applied to a cross-sectional area of an object.
Tensile Strength	The maximum load a material can hold without fracture.
Tightening Torque	A measure of the force used to twist a nut along the threads of a bolt.
Thread Series	Refers to a standard set of pitches and diameters.
UNC	Stands for Unified Coarse Thread and is the standard US thread pattern.
UNF	Stands for Unified Fine Thread and is the standard US thread pattern for fine thread.
Yield Strength	The maximum load before a fastener begins to show specific types of permanent deformities.
8-UN (8 TPI series)	Refers to the number of threads on a fastener being 8 threads per inch.

Common Abbreviations

2, 5, or 8	Refers to the strength grade of a screw or nut.
18-8	Stainless steel with 18% Chrome and 8% Nickel.
316	Stainless steel an austenitic chromium-nickel alloy.
AISI	American Iron and Steel Institute. Details the chemical composition of the steel being used.
ANSI	American National Standards Institute.
ASTM	American Society for Testing and Materials.
BSF	British Standard Fine.
BSW	British Standard Whitworth.
BR	Brass.
CR	Chrome.
CSS	Counter Sunk Screw.
DIN	Deutsches Institut Fur Normung – The German Standards Body- Refers to fasteners that conform to this specific metric standard.
FT	Fully threaded.
Galv.	Galvanized.
GR	Grade.
HDG	Hot dipped galvanized.
HX	Hex.
IFI	Industrial Fastener Institute.
ISO	International Standards Organization.
ksi	Thousands of pounds per square inch.
LH	Left-hand thread.
S/S	Stainless steel.
SAE	Standard American Equivalent.
SAE Pattern (Washers)	A measure of the force used to twist a nut along the threads of a bolt.
TPI	Threads per inch.
USS Pattern (Washers)	These washers have a larger outside diameter than SAE pattern Washers.
Z	Zinc.
Zn/C	Zinc plated with clear chromate coating.
ZN Phos	Zinc Phosphate and oil.
Zn/Wax	Zinc plating with wax coating.
Zn/Y	Zinc plating with yellow chromate coating.

Fastener Materials

Steel

Low Carbon Steel - Contains on average between 0.5% and .25% carbon. Low carbon steel is extremely ductile and tough. An advantage of low carbon steel is the ease of machining and welding the material. Finally, low carbon steel isthe least expensive carbon steel to produce, making it a popular material to use. It is often used in pipeline and auto part applications.

Low Carbon Steel has a minimum tensile strength of 60,000 psi depending on grade

Medium Carbon Steel - Contains on average between 0.25% to 0.60% carbon content. Medium carbon steel is easily heat-treated and has a higher tensile strength than low carbon steel. However, the increased carbon levels make medium carbon steel more difficult to shape and cut. Due to the tough nature of medium carbon steel, it is often used in applications where wear and tear levels are high.

Medium Carbon Steel has a minimum tensile strength of 100,000 psi depending on grade

Alloy Steel - Alloy steel is a carbon steel that contains additives. These additives allow for increased heat treatment possibilities. Due to these additives, alloy steel is able to experience improved properties such as: strength, wear resistance, corrosion resistance, and ductility.

Alloy Steel has a minimum tensile strength of 150,000 psi depending on grade

Stainless Steel

Stainless steel is an alloy steel that has a minimum of 10.5% chromium. This chromium creates an invisible surface layer of chromium oxide, which helps resist oxidation, and makes the metal corrosion-resistant. Stainless steel is, however, susceptible to galling. All Tensile strength is dependant on the grade of stainless steel.

Austenitic Stainless Steel has a minimum tensile strength of 80,000 psi depending on grade

- **Austenitic Stainless Steel** - Austenitic stainless steel has a chromium content of 15% to 20% and between 5% to 19% of nickel. This version of stainless steel offers a higher degree of corrosion resistance than martensitic or ferriticstainless steel.

Martensitic Stainless Steel has a minimum tensile strength of 180,000 psi depending on grade

- **Martensitic Stainless Steel** - Martensitic stainless steel has a chromium content of 12% to 18% and can be hardened by heat treatment. This type of stainless steel is magnetic and not ideal for highly corrosive environments.

Alloy Steel has a minimum tensile strength of 150,000 psi depending on grade

- **Ferritic Stainless Steel** - Ferritic stainless steel has a chromium content of 15% to 18% chromium and is non-heat treatable, has magnetic properties, and very poor weld characteristics. While technically corrosion resistant, there arebetter alternatives.

Ferritic Stainless Steel has a minimum tensile strength of 65,000 psi depending on grade

Other Types of Fastener Materials

Aluminum
Aluminum is a lightweight metal that provides a high level of strength comparative to it's weight. Aluminum's properties allow for it to be easily manipulated. Aluminum can be hot forged, cold-formed, and is easily machinable, and is a very popular material to manufacture fasteners out of.

Aluminum has a minimum tensile strength of 13,000 psi depending on grade

Brass
An alloy made out of copper and zinc, brass is a soft non-ferrous metal with high corrosion resistance and conductivity. Brass is often used for its attractive appearance. Brass's properties make it a low friction, highly durable fastener.

Brass has a minimum tensile strength of 52,200 psi depending on grade

Copper
Often used due to its conductivity and corrosion resistance, copper is a very malleable metal while still offering high levels of strength. Due to its anti-microbial properties, copper is often used in marine, medical, and other industries where sanitation is a priority.

Copper has a minimum tensile strength of 30,500 psi depending on grade

Nickel
A great conductor of heat and electricity, Nickel is a tough metal that offers corrosion resistance. However, nickel is a high-cost metal with magnetic characteristics, which depending on the situation, can limit its uses.

Nickel has a minimum tensile strength of 80,000 psi depending on grade

Titanium
Titanium is considered a super metal. With outstanding corrosion resistance, superior strength to weight ratio, low density, high melting point with high heat resistance, and good anti-corrosion attributes, titanium is extremely useful. Due to its qualities titanium is often used in aerospace, medical and military industries. While titanium is corrosion resistant, it is susceptible to strong acids like sulfuric acid.

Titanium has a minimum tensile strength of 150,000 psi depending on grade

Types of Heat Treating

When manufacturers create fasteners, an important factor that must be determined is what sort of treatment to apply. These treatments will directly impact the properties that are exhibited by the fasteners.

Annealing (Solution Annealing)
A process that involves heating a material to a certain temperature, then cooling at a specific rate. The purpose of this is to improve upon the following material attributes:

- Reduce hardness.
- Improve machinability.Increase ductility.
- Remove internal stresses.

Stress Relieving
A process that is used to treat metal and improve upon some of its attributes. Stress relieving results after heating the material to a specified temperature and then allowing for it to cool by air temperature.

The purpose of this is to improve upon the following material attributes:

- Removes stresses after machining has occurred.
- Can make structures tension free by using stress relieving.

Case Hardening
Case Hardening occurs when a lower carbon iron is placed within a high carbon substance and then heated. This process encourages the transference of carbon from the high carbon material to the low carbon material, which then hardens the surface of the low carbon iron.

The purpose of this is to improve upon the following material attributes:

- Creates a more durable product.
- Increases wear resistance.
- Increased flexibility.
- Improves the lifetime of the material.

Quenching and Tempering
This process involves heating the material and then quickly cooling the substance. The amount of time for each part of this process is entirely dependent on the type of material that is being manipulated.

Benefits of quenching and tempering:

- Creates a less brittle material.
- Can be used to remove material hardness.
- Tougher material.
- Increased strength.

Basic Knowledge

Coatings

A large variety of coatings are available to coat fasteners, with each coating typeproviding a variety of benefits. Below we list 8 different coatings, each with its own unique set of attributes.

Hot Dip Galvanized

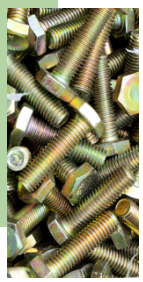
Comprised primarily out of zinc and zinc alloys

- Great corrosion resistance
  - Longer service life
- Matte grey finish
- Low cost across lifecycle
- Additional information:
  - Doesn't work well with GR8 Products
  - Abrasion resistance

Electroplated Zinc

An electroplated layer of zinc covering the fastener

- Good corrosion resistance
  - Avoid salt spray environments
- Comes in a variety of colours and textures.
- Low cost
- Additional information
  - Doesn't perform well in high temperatures
  - Bio-friendly alternative to Cadmiumstance



Dichromate Yellow

Comprised primarily out of zinc and zinc alloys

- Good Corrosion Resistance
  - Avoid salt spray environments
- Yellow finish
- Low cost
- Additional information
  - Can easily be painted and acts as A primer to help paint adhere to the metal
  - Standard Plating on Grade 8 products

Grey Phosphate

Zinc based coating

- Offers some corrosion protection
  - Best used with a top coat for extra corrosion resistance
- Matte grey to dark grey colour Low cost
- Additional information
  - Followed by an oil finish can decrease friction and prevent galling

Coatings

Black Oxide

Chemical treatment of ferrous material converts the top layer to black oxide

- Offers mild corrosion protection
  - Can easily be painted to improve
- corrosion resistance
- Black matte appearance
- Low cost
- Additional information
  - Reduces friction

Xylan Coating

Fluoropolymer-based coating

- Great corrosion protection
- Blue colour
- Higher cost
- Additional information
  - Control friction and lubrication
  - Heat resistance
  - Good adhesion to bolt

Basic Knowledge

Specifications List

To maintain a standard that can be relied upon, ASTM produced specifications that fastener manufacturers must meet in order to be classified within the standard.

Bolt Specific Specifications

ASTM A193	Alloy steel and stainless steel bolting materials. This designation is ideal for high pressure/high temperature usage (Pages 11 - 13).
ASTM A307	Carbon steel bolts and studs (Page 14).
ASTM A325	Heavy hex structural bolts, steel, heat-treated. Now under ASTM F3125 (Page 25).
ASTM A354	Quenched and tempered alloy steel, bolts, studs, and other threaded fasteners (Page 17).
ASTM A449	Medium carbon or alloy steel intended for general use. Applies to headed bolts, rods, and anchor bolts ranging from 1/4" to 3" (Page 18).
ASTM A490	Heavy hex structural bolt grade, similar to GR8 (Page 19).
ASTM A574	Strength grade for socket head cap screws (Page 20).
ASTM F593	Stainless steel bolts, studs, and hex cap screws (Pages 21 - 22).
ASTM F1554	This specification was created to cover anchor bolts designed for anchoring structural supports to concrete foundations (Page 23).
ASTM F3125	Structural bolt specification replacing A325, A325M, A490, A490M, F1852 and F2280 (Page 24 - 25).

Washer Specific Specifications

ASTM F844	General-purpose flat washers (Page 29).
ASTM F436	Hardened steel washers (Page 29).
ASTM F959	Compressible washer type Diameter 1/2" to 1-1/2" (Page 30).
ASTM F2437	Compressible washer type Diameter 1/4" to 2-1/2" (Page 31).

Nut Specific Specifications

ASTM A194	Carbon and alloy steel nuts for high pressure/temperature use. (Page 36-37).

BOLT AND ROD SPECIFICATIONS

ASTM A193

Alloy Steel and Stainless Steel Bolting

This specification covers alloy steel and stainless steel bolting materials for high temperature and high pressure situations. This specification is for bolts and studs that are used in flanges, pressure vessels, fittings and valves.

Within the ASTM A193 designation there are several grades.

Grade B7

- Composition: Chromium-Molybdenum Steel (Heat Treated).
- **Size:**
  - **Up to 2" - 1/2"**
    - 125 Tensile ksi
    - 105 Yield ksi
  - **2-5/8" to 4"**
    - 115 Tensile ksi
    - 95 Yield ksi
  - **4-1/8" to 7"**
    - 100 Tensile ksi
    - 75 Tensile ksi

ASTM A193 Grad B7

Grade B7M

- Composition: Chromium-Molybdenum Steel (Heat Treated).
- **Size:**
- **Up to 4"**
  - 100 Tensile ksi
  - 80 Yield ksi
- **4" - 7"**
  - 100 Tensile ksi
  - 75 Tensile ksi

ASTM A193 Grad B7M

Grade B8 (Class 1)

- Composition: Manufactured with AISI 304 Stainless Steel with Solution Annealing.
- **Size:**
  - **All sizes**
    - 75 Tensile ksi
    - 30 Yield ks

ASTM A193 Grade B8

ASTM A193 – con't

- **Grade B8 (Class 2)**
  - Composition: Manufactured with AISI 304 stainless steel with solution annealing and strain hardening.
- **Size:**
- **Up to 3/4"**
  - 125 Tensile ksi
  - 100 Yield ksi
- **7/8" to 1"**
  - 115 Tensile ksi
  - 80 Yield ksi
- **1-1/8" to 1-1/4"**
  - 105 Tensile ksi
  - 65 Yield ksi
- **1-3/8" to 1-1/2"**
  - 100 Tensile ksi
  - 50 Yield ksi

ASTM A193 Class 2 Grade B8

Grade B8M (Class 1)

- Composition: Manufactured with AISI 316 stainless steel with solution annealing.
- Sizes
- **All sizes**
  - 75 Tensile ksi
  - 30 Yield ksi

ASTM A193 Class 1 Grade B8M

Grade B8M (Class 2)

- Composition: Manufactured with AISI 316 stainless steel with solution annealing and strain hardened.
- **Size:**
  - **Up to 3/4"**
    - 125 Tensile ksi
    - 100 Yield ksi
  - **7/8" to 1"**
    - 115 Tensile ksi
    - 80 Yield ksi
  - **1-1/8" to 1-1/4"**
    - 105 Tensile ksi
    - 65 Yield ksi
  - **1-3/8" to 1-1/2"**
    - 100 Tensile ksi
    - 50 Yield ksi

ASTM A193 Class 2 Grade B8M

ASTM A193 – con't

Grade B16

- Composition: Chromium-Molybdenum-Vanadium alloy steel.
- Sizes
- **Size: up to 2" to 1/2"**
    - 125 Tensile ksi
    - 105 Yield ksi
- **Size: 2-1/2" to 4"**
    - 110 Tensile ksi
    - 95 Yield ksi
- **Size: 4" to 8"**
    - 100 Tensile ksi
    - 85 Yield ksi

Grade B5

- Composition: Manufactured with AISI 501 stainless steel that has been heat-treated.
- Sizes
- **Size: up to 4"**
    - 100 Tensile ksi
    - 80 Yield ksi

Grade B6

- Composition: Manufactured with AISI 410 stainless steel with solution annealing and heat-treated.
- **Size: up to 4"**
    - 110 Tensile ksi
    - 85 Yield ksi

ASTM A193 Grade B16

ASTM A193 Grade B5

ASTM A193 Grade B6

ASTM A307
Carbon Steel Bolts and Studs

Covers carbon steel bolts and studs. These bolts and studs range from 1/4" to 4" in diameter. The grading system for these fasteners are Grades A, B, and C. Fasteners within this standard are tested to adhere to specific values of composition, hardness, yield strength and dimensions.

Grade A

- Composition: Carbon, Manganese, Phosphorus, and Sulfur.
    - 60 Tensile ksi
- Includes headed bolts, threaded rods, and bent bolts.

ASTM A307 Grade A

Grade B

- Composition: Carbon, Manganese, Phosphorus, and Sulfur.
    - 60-100 Tensile ksi
- Includes heavy hex bolts and studs in piping systems with cast iron flanges.

ASTM A307 Grade B

Grade C

- Replaced by F1554 Grade 36.
    - See page 24 for this specification.

ASTM A320
Alloy Steel Materials

This specification covers alloy steel materials used for vessels, valves, fittings and flanges for low temperature use. This specification covers bolts, screws, studs, stud bolts, and bars. Fasteners within this standard are tested to adhere to specific values of composition, hardness, yield strength and dimensions.

L7 Alloy Steel

- Composition: AISI 4140/4140H quenched and tempered.
- Diameter
    - **Size: up to 2-1/2"**
        - 125 Tensile ksi
        - 105 Yield Strength

ASTM A320 L7

L43 Alloy Steel

- Composition: AISI 4340 quenched and tempered.
- Diameter
    - **Size: up to 4"**
        - 125 Tensile ksi
        - 105 Yield Strength

ASTM A320 L43

B8 Class 1 Stainless Steel

- Composition: AISI 304 with solution annealing.
- Diameter
    - **All sizes**
        - 75 Tensile ksi
        - 30 Yield ksi

Class 1 B8M

B8M Class 1 Stainless Steel

- Composition: AISI 316 with solution annealing.
- Diameter
    - **All sizes**
        - 75 Tensile ksi
        - 30 Yield ksi

ASTM A320
Alloy and Stainless Steel Bolting

B8 Class 2 Stainless Steel

- Composition: AISI 304 with solution annealing and strain hardened.
- Diameter
  - **Size: up to 3/4"**
    - 125 Tensile ksi
    - 100 Yield ksi
  - **Size: 7/8" to 1"**
    - 125 Tensile ksi
    - 100 Yield ksi
  - **Size: 1-1/8" to 1-1/4"**
    - 125 Tensile ksi
    - 100 Yield ksi
  - **Size: 1-3/8" to 1 1/2"**
    - 100 Tensile ksi
    - 50 Yield ksi

B8 Class 2

B8M Class 2 Stainless Steel

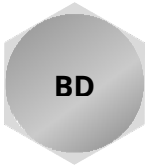
- Composition: AISI 316 with solution annealing and strain hardened.
- Diameter
  - **Size: up to 3/4"**
    - 110 Tensile ksi
    - 95 Yield ksi
  - **Size: 7/8" to 1"**
    - 100 Tensile ksi
    - 80 Yield ksi
  - **Size: 1-1/8" to 1-1/4"**
    - 95 Tensile ksi
    - 65 Yield ksi
  - **Size: 1-3/8" to 1-1/2"**
    - 90 Tensile ksi
    - 50 Yield ksi

B8M Class 2

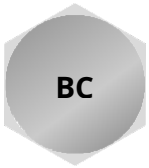
ASTM A354
Quenched and Tempered Alloy Steel

This specification covers bolts that are quenched and tempered alloy steel, bolts, studs and externally threaded fasteners. The class's of fasteners within this designation are grades BC and BD. In addition, this configuration of fastener types are unrestricted and can be a headed bolt, bent bolt or threaded rod.

- **Grade BD**
  - Composition: Quenched and tempered alloy steel.
  - **All sizes**
    - 150-173 Tensile ksi
    - 130 Yield ksi
- **Grade BC**
  - Composition: Quenched and tempered alloy steel.
  - **Size: 1/4" to 2-1/2"**
    - 125 Tensile ksi
    - 109 Yield ksi
  - **Size: over 2-1/2"**
    - 115 Tensile ksi
    - 99 Yield ksi



ASTM A354 Grade BD



ASTM A354 Grade BC

ASTM A449
1/4" to 3" Fasteners

This designation covers headed bolts, rods, and anchor bolts that have diameters ranging from 1/4" to 3". This designation is mechanically the same as ASTM A325 and Grade 5 bolts; however, the two designations are tested differently. Another difference is the range of diameters ASTM A449 covers, which includes diameters greater than those available for ASTM A325. ASTM A449 is a medium carbon or alloy steel that is considered to be medium strength in nature and received its mechanical values through a heat-treating process.

- **Type 1**
  - Composition: Medium carbon alloy steel.
- **Type 2**
  - Composition: Low carbon martensite or medium carbon martensite steel.

ASTM A449

- Mechanical properties of both types fall under the following specifications:
- **Size: 1/4" to 1"**
  - 120 Tensile ksi
  - 92 Yield ksi
- **Size: 1-1/8" to 1-1/2"**
  - 105 Tensile ksi
  - 81 Yield ksi
- **Size: 1-5/8" to 3"**
  - 90 Tensile ksi
  - 58 Yield ksi

ASTM A490
Structural Connection Bolts

This specification covers bolts that are used in structural connections. These bolts have shorter thread lengths than the standard type of hex bolts. While similar to A325 structural heavy hex bolts, A490 bolts are made out of alloy steel instead of medium carbon steel.

A490 is not allowed to be coated with HDG, mechanical deposition, or electroplating due to the potential for hydrogen embrittlement.

Type 1

- Composition: Medium carbon and alloy steel.
- **Size: 1/2" to 1-1/2"**
  - 150-173 Tensile ksi
  - 130 Yield ksi

ASTM A490 Type 1

Type 2

- Withdrawn type.

Type 3

- Composition: Weathering steel.
- **Size: 1/2" to 1-1/2"**
  - 150-173 Tensile ksi
  - 130 Yield ksi

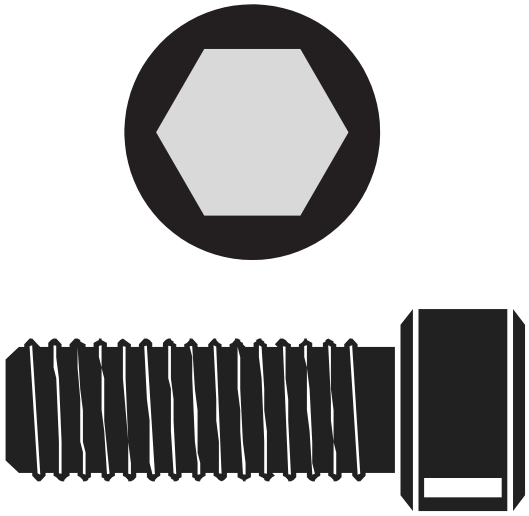
ASTM A490 Type 3

ASTM A574
Socket Head Cap Screws

This specification covers the specification of alloy steel socket head cap screws between the diameters of 0.060 through 4". These quenched and tempered screws are used in situations where high strength is necessary.

- Composition: Medium carbon and alloy steel.
- **Size: 1/2" or less than.**
  - 180 Tensile ksi
  - 153 Yield ksi
  - 39-45 HRC
  - 140 Proof Load

- **Size: 1/2" or greater.**
  - 170 Tensile ksi
  - 153 Yield ksi
  - 37-45 HRC
  - 135 Proof Load



ASTM A593
Stainless Steel Bolts, Screws, and Studs

This specification covers the requirements for stainless steel bolts, hex cap screws and studs within/including the diameters of 1/4" to 1-1/2". This specification covers fasteners that are being used for general purpose, and includes a wide variety of alloy types. The grades listed below are the most commonly used, in the ASTM F593 specification.

Group 1

- Contains alloy types: 304, 305, 384, 304L, XM1, 18-9LW, 302HQD.Falls into the stainless steel austenitic family.
- AF
- **Size: 1/4" to 1-1/2"**
    - 65 to 85 Tensile ksi
    - 20 Yield KSI

A

- **Size: 1/4" to 1-1/2"**
    - 75 to 100 Tensile ksi
    - 30 Yield ksi

CW1

- **Size: 1/4" to 5/8"**
    - 100 to 150 Tensile ksi
    - 65 Yield ksi

CW2

- **Size: 3/4" to 1-1/2"**
    - 85 to 140 Tensile ksi
    - Yield ksi

ASTM A593
Stainless Steel Bolts, Screws, and Studs

This specification covers the requirements for stainless steel bolts, hex cap screws and studs within/including the diameters of 1/4" to 1-1/2". This specification covers fasteners that are being used for general purpose, and includes a wide variety of alloy types. The grades listed below are the most commonly used, in the ASTM F593 specification.

Group 2

- Contains alloy types: 316, 316L
  - Falls into the stainless steel austenitic family.
    - AF
    - **Size: 1/4" to 1-1/2"**
      - 65 to 85 Tensile ksi
      - 20 Yield ksi
    - A
      - **Size: 1/4" to 1-1/2"**
        - 75 to 100 Tensile ksi
        - 30 Yield ksi
    - CW1
      - **Size: 1/4" to 5/8"**
        - 100 to 150 Tensile ksi
        - 65 Yield ksi
  - CW2
      - **Size: 3/4" to 1-1/2"**
        - 85 to 140 Tensile ksi
        - Yield ksi

Group 3

- Contains 321, 347 alloy
  - Austenitic

Group 4

- Contains 430, 430F alloy
  - Ferritic

Group 5

- Contains 410, 416, 416Se alloy
  - Martensitic

Group 6

- Contains 431 Alloy
  - Martensitic

Group 7

- Contains 630 (17-4) alloy
  - Precipitation hardening

ASTM F1554

Anchor Bolt Specification

This specification was created to cover anchor bolts designed for anchoring structural supports to concrete foundations (Example: Light posts being secured to the ground).

Within this designation there are three grades

- **Grade 36** - Blue colour coding.
- Composition: Low carbon steel
- **Size: 1/2" to 4"**
    - 36 Yield ksi
    - 58-80 Tensile ksi

AB36

- **Grade 55** - Yellow colour coding.
- Composition: Modified mild steel, low alloy.
- **Size: 1/2" to 4"**
    - 55 Yield ksi
    - 79-95 Tensile ksi

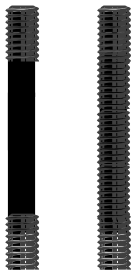
AB55

- **Grade 105** - Red colour coding.
- Composition: Heat treated medium carbon alloy steel.
- **Size: 1/2" to 3"**
    - 105 Yield ksi
    - 125-150 Tensile ksi

AB105

Anchor Bolt Types

Partially and Fully Thread Rod



L Shaped

Anchor Bolt Hex Cap

ASTM F3125
Steel and Alloy Steel Structural Bolts

This specification covers structural bolts made from steel and alloy steel, in two strength grades, two types, and styles. This specification consolidates the following specifications: A325, A490, F1852, F2280. Within this specification types, 1 and 3 share the same yield and tensile strength. These bolts are to be used as structural connections. The sizes of these bolts range from 1/2" - 1-1/2"

Grade A325

- Type 1 - Carbon, carbon boron, alloy, or alloy boron steel.
- Type 3 - Weathering steel (low carbon steel with corrosion resistance and increased strength).
    - 120 ksi Tensile strength
    - 92 ksi Yield strength

Grade A490

- Type 1 - alloy steel and/or boron alloy steel.
- Type 3 - Weathering steel (low carbon steel with corrosion resistance and increased strength).
    - 150-173 ksi Tensile strength
    - 130 ksi Yield strength

Grade F1852

- Type 1 - Carbon, carbon boron, alloy, or alloy boron steel.
- Type 3 - Weathering Steel (low carbon steel with corrosion resistance and increased strength).
    - 120 ksi Tensile strength
    - 92 ksi Yield strength

Grade F2280

- Type 1 - Alloy steel and/or boron alloy steel.
- Type 3 - Weathering steel (low carbon steel with corrosion resistance and increased strength).
    - 150 ksi Tensile strength
    - 130 ksi Yield strength

ASTM F3125 Type 1
Grade A325

ASTM F3125 Type 3
Grade A325

ASTM F3125 Type 1
Grade A490

ASTM F3125 Type 3
Grade A490

ASTM F3125
Steel and Alloy Steel Structural Bolts

Grade A325M

- Type 1 - Carbon, carbon boron, alloy, or alloy boron steel.
- Type 3 - Weathering steel (low carbon steel with corrosion resistance and increased strength).
    - 830 MPa Tensile strength
    - 660 MPa Yield strength

Grade A490M

- Type 1 - Alloy steel and/or boron alloy steel.
- Type 3 - Weathering steel (low carbon steel with corrosion resistance and increased strength).
    - 1040MPa Tensile strength
    - 940MPa Yield strength

ASTM F3125 Type 1 Grade A325M

ASTM F3125 Type 3 Grade A325M

ASTM F3125 Type 1 Grade A490M

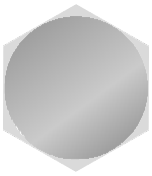
ASTM F3125 Type 3 Grade A490M

SAE J429
SAE Standard

Covers the specifics for inch series fasteners that are used in automotive and other related industries, within/including sizes up to 1-1/2".

Grade 1

- Material: Low or medium carbon steel
- **Size: 1/4" to 1-1/2"**
    - 60 Tensile ksi
    - 36 Yield ksi



SAE J429 Grade 2

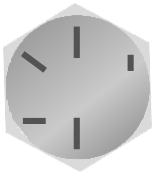
Grade 2

- Material: Low or medium carbon steel
- **Size: 1/4" to 3/4"**
    - 74 Tensile ksi
    - 57 Yield ksi
- **Size: over 3/4" to 1-1/2"**
    - 60 Tensile ksi
    - 36 Yield ksi

SAE J429 Grade 5

Grade 5

- Material: Medium carbon steel
- **Size: 1/4" to 1"**
    - 120 Tensile ksi
    - 92 Yield ksi
- **Size: over 1" to 1-1/2"**
    - 105 Tensile ksi
    - 81 Yield ksi



SAE J429 Grade 8

Grade 8

- Material: Medium carbon alloy steel
- **Size: 1/4" to 1-1/2"**
    - 150 Tensile ksi
    - 130 Yield ksi

Washers

Uses for Different Washer Types

A washer is an additional factor of a fastener system that is used to spread out the load of a bolt or nut. Below are some different variations of washers.

Flat Washer

A thin flat washer with a cylindrical hole in the center of its diameter. Plain flat washers are the most common type of washer and are used to spread out the load of fasteners during engagement.

Fender Washer

Similar to flat washers with the exception of a much larger outside diameter. Used to distribute load evenly, these fasteners get their name from being used to attach fenders onto automobiles.

Bevel Washer

When trying to bolt together two un- parallel surfaces, bevel washers can be used to offset the difference. Designed for I-beams as the slope matches I- beams.

Split Lock Washer

Used to increase tension between a bolt and a nut, split lock washers are ideal for decreasing the likelihood of fasteners becoming loose.

Washers

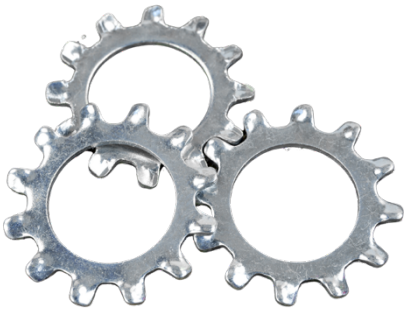
Uses for Different Washer Types

Internal Tooth Lock Washer

Used in situations where nut and bolts need to be prevented from loosening, the internal teeth of this washer bite into the mating surface. In addition to keeping fasteners from loosening, these washers also absorb shock vibrations through the teeth.

External Tooth LockWasher

The teeth of the external tooth lock washer extend outward and bite into the bearing surface instead of the mating surface. The purpose of this washer is the same as the internal, which is to prevent loosing of the nut and bolt.

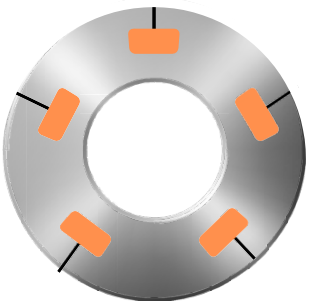


Belleville Disc Spring

Belleville disc washer springs are conically shaped and are able to support high loads. These washers produce small deflections and are used to solve problems such as vibration, thermal expansion, relaxation and bolt creep issues.

Compressible Washer

These types of washers use direct tension indicators to let the user know when to stop tightening. This can be done by the release of an orange dye, once the compression limit has been passed. However, the dye is not an essential part of the specification for compressible washers.



ASTM F844
General Purpose Flat Washer

This specification is very broad in what it covers, covering round and other shapedflat washers. These washers are typically unhardened and will have a wider outside diameter than hardened steel washers. The purpose of these washers is to be usedas a bearing surface under the head of other fasteners. The purpose of this device is to spread out the pressure of a torqued fastener over a larger surface area.

Markings: None Required
Mechanical Properties: ASTM F844 is not held to any mechanical requirements unless specified otherwise.This type of Washer typically doesn't have certification documents.

ASTM F436
Hardened Steel Washer

This specification has more requirements than the ASTM F844 specification. These washers are heat treated and can be made out of two different materials, carbon steel, and weathering steel. These washers are intended for general purpose usage.

Markings: Stamped with F436
Dimensions: 1/2" through 4"
Mechanical Properties:

- Type 1: Carbon steel
- Type 3: Weathering steel

Variety: Can come in different shapes such as, circular, clipped, and beveled.
Hardness Scale: 38 to 45 HRC Unless Zinc Coated using the hot dip process, then it is allowable to have 26 to 45 HRC.

ASTM F844

Compressible Washer Types

ASTM F959 covers the diameters of 1/2" to 1-1/2" compressible washer types. The purpose of these specifications is to ensure that washers are able to achieve a specific minimum bolt tension.

While not a part of the specification, these washers can be manufactured to release an orange dye when tightened, helping to indicate when the minimum bolt tension has been met.

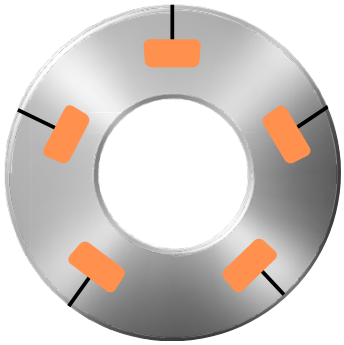
Markings: Orange dye
Dimensions: 1/2" through 1-1/2"
Grades Available

- Type 1: Carbon steel
- Type 3: Weathering steel

Variety: Can come in different shapes such as, circular, clipped, and beveled.
Hardness Scale: 38 to 45 HRC unless zinc coated using the Hot Dip Process, then it is allowable to have 26 to 45 HRC.

Load Range for Type 325 and 325-3 in kips

1/2"	=	12-14
5/8"	=	19-23
3/4"	=	28-34
7/8"	=	39-47
1"	=	51-61
1-1/8"	=	56-67
1-1/4"	=	71-85
1-3/8"	=	85-102
1-1/2"	=	103-124



Load Range for Type 490 and 490-3 in kips

1/2"	=	15-18
5/8"	=	24-29
3/4"	=	35-42
7/8"	=	49-59
1"	=	64-77
1-1/8"	=	80-96
1-1/4"	=	102-122
1-3/8"	=	121-145
1-1/2"	=	148-178

ASTM F2437
Compressible Washer Type

ASTM F959 covers the diameters of 1/4" to 2-1/2" compressible washer types. The purpose of these specifications are to ensure that washers are able to achieve a specific minimum bolt tension. This specification covers two types of washers each with two difference grades.

Markings: Stamped with F436
Grades Available:

- Type 1
- **Dimensions: 1/2" through 1-1/2"**
  - Grade 5
  - Grade 8
- Type 2
- **Dimensions: 1/4" through 2-1/2"**
  - Grade 55
  - Grade105

Type 1

Mean Compression Load Range (lbs)		
Diameter	Grade 5	Grade 8
1/2"	9,700 -10,700	13,700-15,340
5/8"	15,550 -17,200	21,850 - 24,200
3/4"	22,600 -25,000	31,900 - 35,300
7/8"	30,3850 -34,100	43,550 - 48,100
1"	40,200 - 44,400	56,700 - 62,700
1-1/8"	40,250 - 44,450	73,150 - 80,900
1-1/4"	51,100 - 56,450	91,750 -101,450
1-3/8"	61,150 - 67,600	112,450 - 124,250
1-1/2"	74,350 - 82,150	135,150-149,400
1-3/4"	74,450 - 82,300	177,850 -196,500
2"	98,000 -108,300	236,850 - 261,750
2-1/4"	127,400 -140,800	277,900 - 307,100
2-1/2"	156,750 -173,250	379,600 - 419,600

Type 2

Mean Compression Load Range (lbs)		
Diameter	Grade 55	Grade 105
1/2"	4,450 - 4,900	8,500 - 9,400
5/8"	7,050 -7,800	13,500 - 15,000
3/4"	10,500 -11,600	20,000 - 22,150
7/8"	14,500 -16,000	27650 - 30550
1"	19,000 - 21,000	36250 - 40100
1-1/8"	23,950 - 26,450	47300 - 52300
1-1/4"	30,400 - 33,600	59850 - 66150
1-3/8"	38,550 - 42,600	73800 - 81600
1-1/2"	44,050 - 48,700	89,300 - 98,700
1-3/4"	59,550 - 65,850	124,600 - 137,750
2"	78,650 -86,950	165,800 - 183,300
2-1/4"	102,050 -112,750	212,900 - 235,350
2-1/2"	125,400 - 138,600	240,550 - 265,850

Belleville Washers

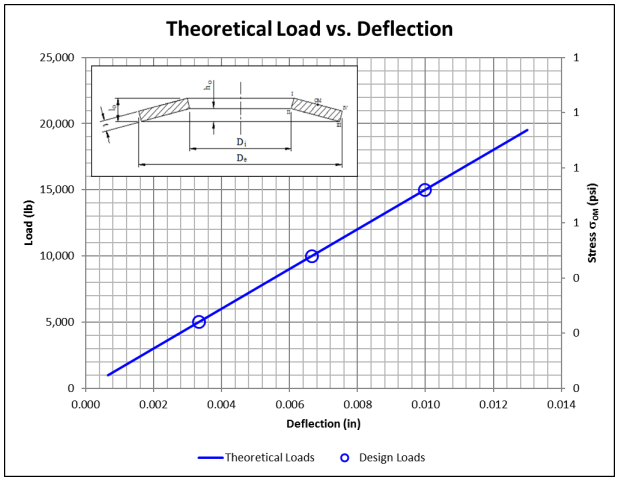
A Belleville washer or disc spring is a conical-shaped spring with an open center. It is shaped much like a washer and is typically smaller than a coiled spring. Because Belleville washers can bear a much larger load relative to its deflection rate than a coiled spring, they are ideal for cushioning heavy loads with short motion.

Like all springs, a Belleville disc spring will deflect in response to a load. Belleville washers and disc springs exhibit low deflections relative to high loads. The relationship between the load and deflection is non-linear, particularly as load increases. This quality makes Belleville washers and disc springs well-suited to areas with constant thrust that must stand up to heavy wear.

Advantages of Belleville Washers

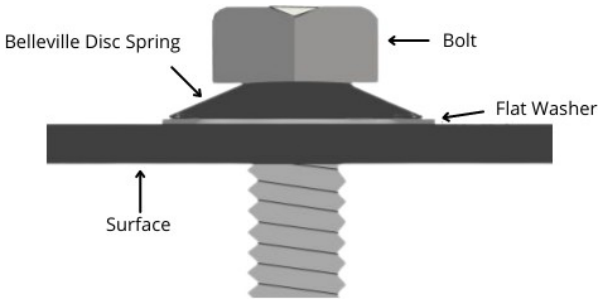
- Conserve space.
- Offer a long service life.
- Can be used in conjunction with coiled springs.
- Offer great versatility when stacked in series or in parallel. Increase the reliability of machinery.
- Prevent bolt failures.
- Maintain the positioning accuracy of ball bearings. Minimize thermal expansion.
- Self-damping.
- Distribute loads evenly. Absorb shocks.
- Prevents joint failures, leaks and loosening.

Belleville Washers



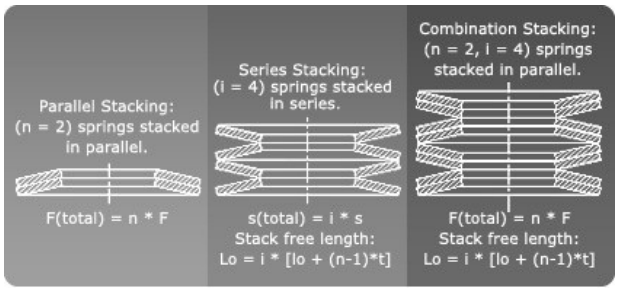
Spring Rate

The spring rate is the amount of force associated with the deflection of a spring measured in lb/in or N/mm. Every spring has its own spring rate, depending on its geometry and material.
The formula uses Poisson's ratio, Young's modulus, & the dimensions of the Belleville. Engineers can then use these variables to determine the spring you need, based on your application.



Application of Flat Washers

Addition of a flat washer under a Belleville can increase effectiveness by spreading out the load. In addition, flat washers can be used to keep Belleville's from biting into softer metals.



Customize Your Deflection and Load

Stacking Belleville disc springs allows for precise customization of the load and/or deflection of the springs.

- Stacking in parallel (same direction) will increase load.
- Stacking in series (opposite directions) will increase deflection.
- Belleville disc springs can also be stacked as a combination of the two alignments.

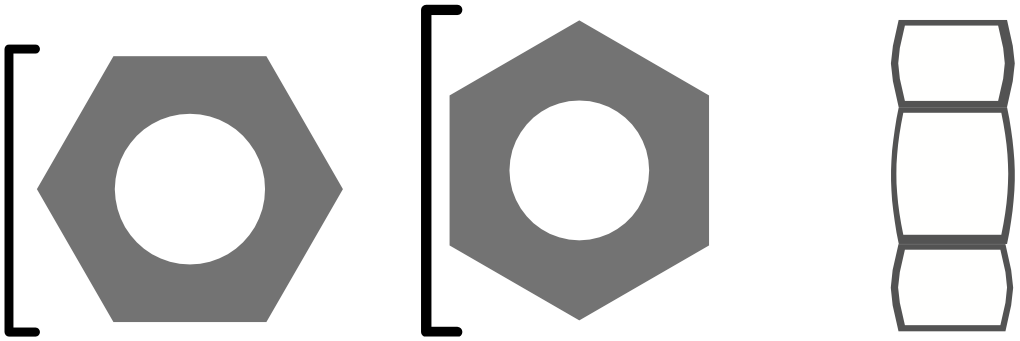
The exact configuration of Belleville disc springs depends on the requirements of the application.

Hex Nut VS. Heavy Hex Nut

Measurements

Heavy Hex Nut Specifications

Nominal Size	Across Flats	Thickness
1/4"	1/2"	15/64"
5/16"	9/16"	19/64"
3/8"	11/16"	23/64"
7/16"	3/4"	27/64"
1/2"	7/8"	31/64"
9/16"	15/16"	35/64"
5/8"	1-1/16"	39/64"
3/4"	1-1/6"	47/64"
7/8"	1-7/16"	55/64"
1"	1-5/8"	63/64"
1-1/8"	1-13/16"	1-7/64"
1-1/4"	2"	1-7/32"
1-3/8"	2-3/16"	1-11/32"
1-1/2"	2-3/8"	1-15/32"
1-5/8"	2-9/16"	1-19/32"
1-3/4"	2-3/4"	1-23/32"
1-7/8"	2-15/16"	1-27/32"
2"	3-1/8"	1-31/32"
2-1/4"	3-1/2"	2-13/64"
2-1/2"	3-7/8"	2-29/64"
2-3/4"	4-1/4"	2-45/64"
3"	4-5/8"	2-61/64"
3-1/4"	5"	3-3/16"
3-1/2"	5-3/8"	3-7/16"
3-3/4"	5-3/4"	3-11/16"
4"	6-1/8"	3-15/16"

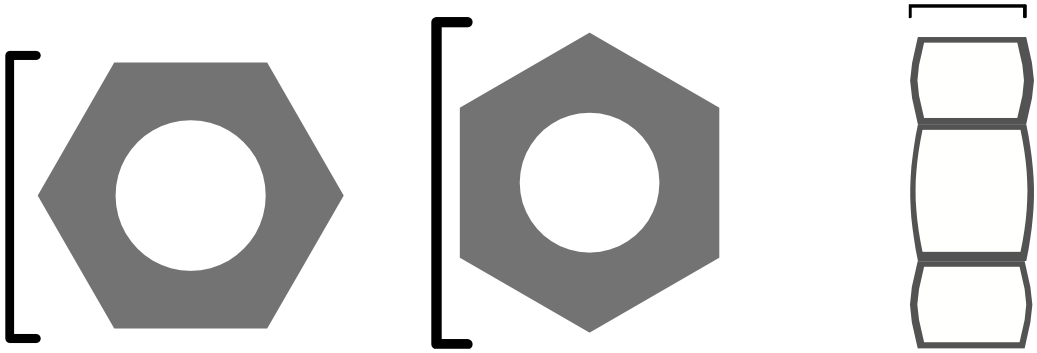


Hex Nut VS. Heavy Hex Nut

Measurements

Hex Nut Specifications

Nominal Size	Across Flats	Thickness
1/4"	7/16"	7/32"
5/16"	1/2"	17/64"
3/8"	9/16"	21/64"
7/16"	11/16"	3/8"
1/2"	3/4"	7/16"
9/16"	7/8"	31/64"
5/8"	15/16"	35/64"
3/4"	1/18"	41/64"
7/8"	1-5/16"	3/4"
1"	1-1/2"	55/64"
1-1/8"	1-11/16"	31/32"
1-1/4"	1-7/8"	1-1/16"
1-3/8"	2-1/16"	1-11/16"
1-1/2"	2-1/4"	1-9/32"
1-5/8"	2-7/16"	1-25/64"
1-3/4"	2-5/8"	1-1/2"
1-7/8"	2-15/16"	1-27/32"
2"	3"	1-23/32"
2-1/4"	3-3/8"	1-59/64"
2-1/2"	3-3/4"	2-9/64"
2-3/4"	4-1/8"	2-23/64"
3"	4-1/2"	2-37/64"
3-1/4"	N/A	N/A
3-1/2"	N/A	N/A
3-3/4"	N/a	N/A
4"	N/A	N/A



ASTM A194
Carbon and Alloy Steel Nuts

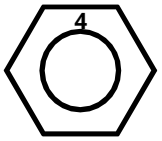
ASTM A194 is a specification that covers stainless steel, carbon and other alloy nuts used in high pressure/high temperature situations. These sizes range from 1/4" to 4".

Grade 2
- Material: Medium carbon steel
  - 159-352 HRC

Grade 2H
- Material: Carbon steel
  - 24-35HRC
- **Over 1-1/2"**
  - 35 HRC Max
  - 95 HRB Min

Grade 2HM
- Material: Carbon steel
  - 84-99 HRB

Grade 4 (Removed from specification)
- Material: Carbon, molybdenum steel
  - 24-35 HRC



Grade 7
- Material: Chromium molybdenum steel type's 4140, 4142, 4145, 4140H, 4142H, 4145H
  - 24-35 HRC

Grade 7M
- Material: Chromium-molybdenum steel type's 4140, 4142, 4145, 4140H, 4142H, 4145H
  - 84-99 HRB

Grade 8
- Material: Austenitic stainless steel type 304 32 HRC Max
  - 60 HRB Min

Grade 8M
- Material: Austenitic stainless steel type 316 32 HRC Max
  - 60 HRB Min

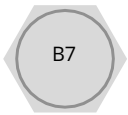
ASTM A194
Carbon and Alloy Steel Nuts

ASTM A194 is a specification that covers stainless steel, carbon and other alloy nuts, which are used in high pressure/high temperature situations. These sizes range from 1/4" to 4".

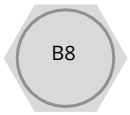
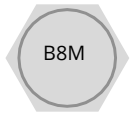
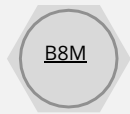
Nominal Diameter	Threads Per Inch	Proof Load*, lbf					
		Grade 8,8C,8M,8T,8F		Grades 2,2HM,6,6F,7M		Grades 2H,4,7,16	
		Heavy Hex	Hex	Heavy Hex	Hex	Heavy Hex	Hex
1/4"	20	2,540	2,380	4,770	4,300	5,570	4,770
5/16"	18	4,190	3,930	7,860	7,070	9,170	7,860
3/8"	16	6,200	5,810	11,620	10,460	13,560	11,620
7/16"	14	8,500	7,970	15,940	14,350	18,600	15,940
1/2"	13	11,350	10,640	21,280	19,160	24,830	21,280
9/16"	12	14,560	13,650	27,300	24,570	31,850	27,300
5/8"	11	18,080	16,950	33,900	30,510	39,550	33,900
3/4"	10	26,720	25,050	50,100	45,090	58,450	50,100
7/8"	9	36,960	34,650	69,300	62,370	80,850	69,300
1"	8	48,480	45,450	90,900	81,810	106,000	90,900
1-1/8"	8	63,200	59,250	118,500	106,700	138,200	118,500
1-1/4"	8	80,000	75,000	150,000	135,000	175,000	150,000
1-3/8"	8	98,640	92,450	185,000	166,500	215,800	185,000
1-1/2"	8	119,360	111,900	223,800	201,400	261,000	223,800

**Proof loads are based on what the specification calls for.*

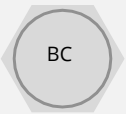
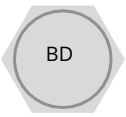
Bolt and Stud Marking Chart

Markings	Specification	Material	Nominal Size Range	Min Tensile (ksi)	Min Yield (ksi)	Proof Load (ksi)
	SAE J429 Grade 2	Low or Medium Carbon Steel	1/4" to 3/4" 7/8" to 1-1/2"	74 60	57 36	55 33
	ASTM A307 Grade A	Low Carbon Steel	1/4" to 4"	60	-	-
	ASTM A307 Grade B	Low Carbon Steel	1/4" to 4"	Min 60 Max 100	-	-
	SAE J429 Grade 5	Medium Carbon Steel Quenched & Tempered	1/4" to 1" 1-1/8" to 1-1/2"	120 105	92 81	85 74
	ASTM A449 Type 1	Medium Carbon Steel Quenched & Tempered	1/4" to 1" 1-1/8" to 1-1/2" 1-5/8" to 3"	120 105 90	92 81 58	85 74 55
	SAE J429 Grade 8	Medium Carbon Alloy Steel Q & T	1/4" to 1-1/2"	150	130	120
	ASTM A354 Grade BD	Alloy Steel Quenched & Tempered	1/4" to 2-1/2" 2-1/2" to 4"	150 140	130 115	120 105
	ASTM A193 Grade B7	AISI 4140, 4142, or 4145	1/4" to 2-1/2" 2-3/4" to 4" 4" to 7"	125 115 100	105 95 75	- - -
	ASTM A193 Grade B7M 100% Hardness Tested	AISI 4140, 4142, or 4145	1/4" to 4" 4" to 7"	100 100	80 75	- -
	ASTM A193 Grade B16	Chrome Molybdenum Vanadium Alloy Steel	1/4" to 2-1/2" 2-3/4" to 4" 4" to 8"	125 110 100	105 95 85	- - -
	ASTM A193 Grade B16	AISI 4140, 4142, or 4145	1/4" to 2-1/2"	125	105	-

Bolt and Stud Marking Chart

Markings	Specification	Material	Nominal Size Range	Min Tensile (ksi)	Min Yield (ksi)	Proof Load (ksi)
	ASTM A320 Grade L7M 100% Hardness Tested	AISI 4140, 4142, Or 4145	1/4" to 2-1/2"	100	80	-
	ASTM A193 ASTM A320 Grade B8	AISI 304	1/4" and Larger	75	30	-
	ASTM A193 ASTM A320 Grade B8 Class 2	AISI 304 Strain Hardened	1/4" to 3/4" 7/8" to 1" 1-1/8" to 1-1/4" 1-1/4" to 1-1/2"	125 115 105 100	100 80 65 50	- - - -
	ASTM A193 ASTM A320 Grade B8C	AISI 347	1/4" and Larger	75	30	-
	ASTM A193 ASTM A320 Grade B8C Class 2	AISI 347 Strain Hardened	1/4" to 3/4" 7/8" to 1" 1-1/8" to 1-1/4" 1-1/4" to 1-1/2"	125 115 105 100	100 80 65 50	- - - -
	ASTM A193 ASTM A320 Grade B8M	AISI 316	1/4" and Larger	75	30	-
	ASTM A193 ASTM A320 Grade B8M Class 2	AISI 316 Strain Hardened	1/4" to 3/4" 7/8" to 1" 1-1/8" to 1-1/4" 1-1/4" to 1-1/2"	110 100 95 90	95 80 65 50	- - - -
	ASTM A193 ASTM A320 Grade B8T	AISI 321	1/4" and Larger	75	30	-
	ASTM A193 ASTM A320 Grade B8T Class 2	AISI 321 Strain Hardened	1/4" to 3/4" 7/8" to 1" 1-1/8" to 1-1/4" 1-1/4" to 1-1/2"	125 115 105 100	100 80 65 50	- - - -
	ASTM A325 Type 1	Medium carbon Steel Quenched & Tempered	1/2"to 1" 1-1/8" to 1-1/2"	120 105	92 81	85 74
	ASTM A325 Type 3	Atmospheric Corrosion Resisting Steel Q & T	1/2" to 1" 1-1/8" to 1-1/2"	120 105	92 81	85 74
	ASTM A490 Type 1	Alloy steel Quenched & Tempered	1/2" to 1-1/2"	Min 150 Max 173	130	120

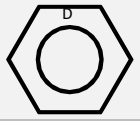
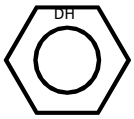
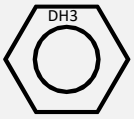
Bolt and Stud Marking Chart

Markings	Specification	Material	Nominal Size Range	Min Tensile (ksi)	Min Yield (ksi)	Proof Load (ksi)
	ASTM A449 Type 1	Medium Carbon Alloy Steel	1/4" to 1" 1" to 1-1/2" 1-1/2" to 3"	120 105 90	92 81 58	-
	ASTM A449 Type 2	Low Carbon, Martensite (sometimes Medium Carbon)	1/4" to 1"	120	92	-
	ASTM A354 Grade BC	Medium Carbon Alloy Steel, Quenched & Tempered	1/4" to 2-1/2" 2-5/8" to 4"	125 115	109 94	10 95
	ASTM A354 Grade BD	Medium Carbon Alloy Steel, Quenched & Tempered	1/4" to 2-1/2" 2-5/8" to 4"	150 140	130 115	120 105
	ASTM A320 Grade L43	AISI 4340	1/4" to 4"	125	105	-
	ISO R898 Class 8.8	Medium Carbon Quenched & Tempered	4mm and larger	830 MPa 120 ksi	660 MPa 95 ksi	600 MPa 87 ksi
	ISO R898 Class 10.9	Alloy Steel Quenched & Tempered	4 mm and larger	1040 MPa 150 ksi	940 MPa 136 ksi	830 MPa 120 ksi
	ISO R898 Class 12.9	Steel Alloy with Chromium and Nickel	4mm and larger	1220 MPa 177 ksi	1100MPa 160 ksi	970 MPa 140 ksi
	F1554 Grade 36	Low Carbon Steel	1/2" to 4"	58-80	I55	-
	F1554 Grade 55	Low Alloy Steel	1/2" to 2" 2-1/4" to 2-1/2" 2-3/4" to 3" 3-1/4" to 4"	75-95 75-95 75-95 75-95	55 55 55 55	- - - -
	F1554 Grade 105	Alloy Heat Treated Steel	1/2" to 3"	125-150	105	-
	ASTM A574	Medium Carbon Alloy Steel Quenched and Tempered	1/2"> 1/2"<	180 170	153 153	140 135

Nut Markings Chart

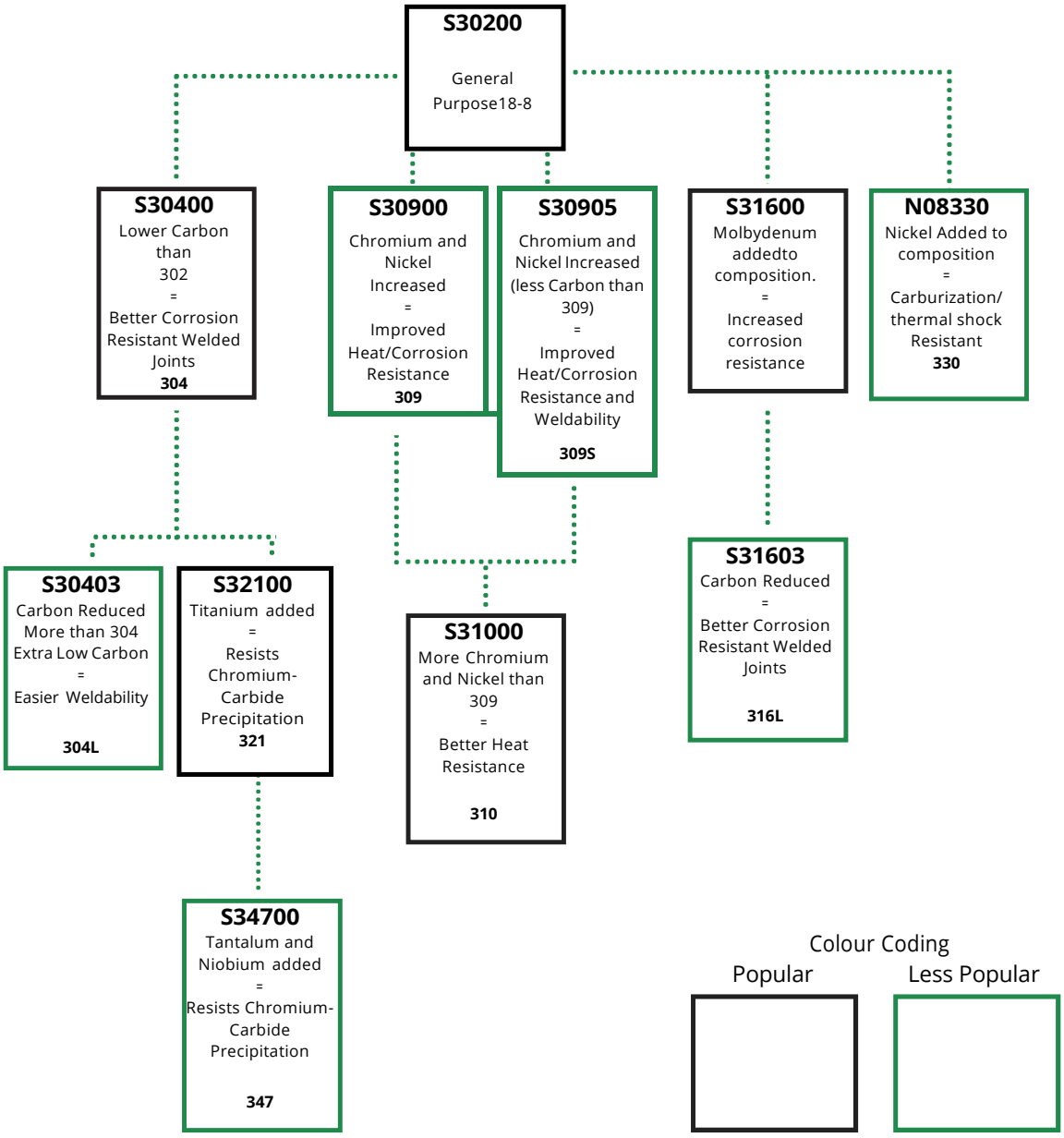
Markings	Specification	Material	Nominal Size Range	Hardness Min	Rockwell Max	Proof Load (ksi)
	ASTM A194 Grade 2	Carbon Steel	1/4" - 4"	159HRC	352HRC	150
	ASTM A194 Grade 2H	Carbon Steel Quenched and Tapered	1/4" - 4"	24HRC	38HRC	175
	ASTM A194 Grade 2HM	Carbon Steel Quenched and Tapered	1/4" - 4"	159HRC	237HRC	150
	ASTM A194 Grade 4	Carbon Alloy Steel Quenched and Tapered	1/4" - 4"	24HRC	38HRC	175
	ASTM A194 Grade 7	Carbon Alloy Steel Quenched and Tapered	1/4" - 4"	24HRC	38HRC	175
	ASTM A194 Grade 7M	Carbon Alloy Steel Quenched and Tapered	1/4" - 4"	159HRC	237HRC	150
	ASTM A194 Grade 8	Stainless Steel AISI 304	1/4" - 4"	126HRC	300HRC	80
	ASTM A194 Grade 8M	Stainless Steel AISI 316	1/4" - 4"	126HRC	300HRC	80
	ASTM A563 Grade O	Carbon Steel	1/4" - 1-1/2"	B55	C32	69
	ASTM A563 Grade A	Carbon Steel	1/4" - 1-1/2"	B68	C32	90
	ASTM A563 Grade B	Carbon Steel	1/4" - 1" 1"-1-1/2""	B69	C32	120 105

Nut Markings Chart

Markings	Specification	Material	Nominal Size Range	Hardness Min	Rockwell Max	Proof Load (ksi)
	ASTM A563 Grade C	Carbon Steel can be Quenched and Tempered	1/4" - 4"	B78	C32	144
	ASTM A563 Grade C3	Atmospheric Corrosion resistant steel,	1/4" - 4"	B78	38HRC	144
	ASTM A563 Grade 2HM	Carbon Steel, can Quenched and Tapered	1/4" - 4"	B84	C38	150
	ASTM A563 DH	Carbo Steel Quenched and Tapered	1/4" - 4"	24HRC	38HRC	175
	ASTM A563 DH3	Atmospheric Corrosion resistant steel	1/4" - 4"	24HRC	38HRC	175

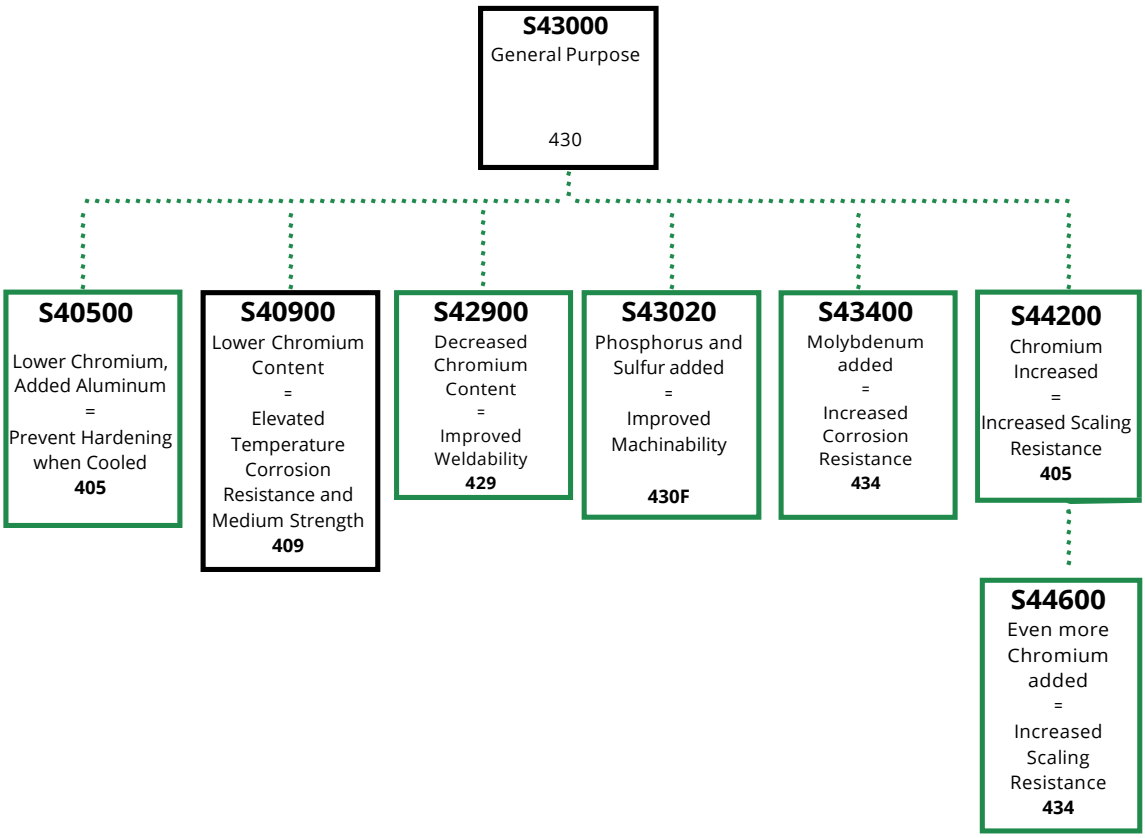
Austenitic Chart

With such a wide variety of metal types and each having specific qualities that make them beneficial, it's important to know the different types within a metal group and the benefits, each one brings. Below are the different grades of austenitic steel. While austenitic steel offers an overall high grade of corrosion resistance, different austenitic types provide small differences. Below are some popular Austenitic grades and the changes that give them their varying properties.



Ferritic Chart

With such a wide variety of metal types and each having specific qualities that make them beneficial, it's important to know the different types within a metal group and the benefits, each one brings. Below are the different grades of austenitic steel. While Ferritic steel is magnetic and not ideal for welding, there are other characteristics that can occur depending on a variety of factors. Below are some popular Ferritic grades and the changes that give them their varying properties.



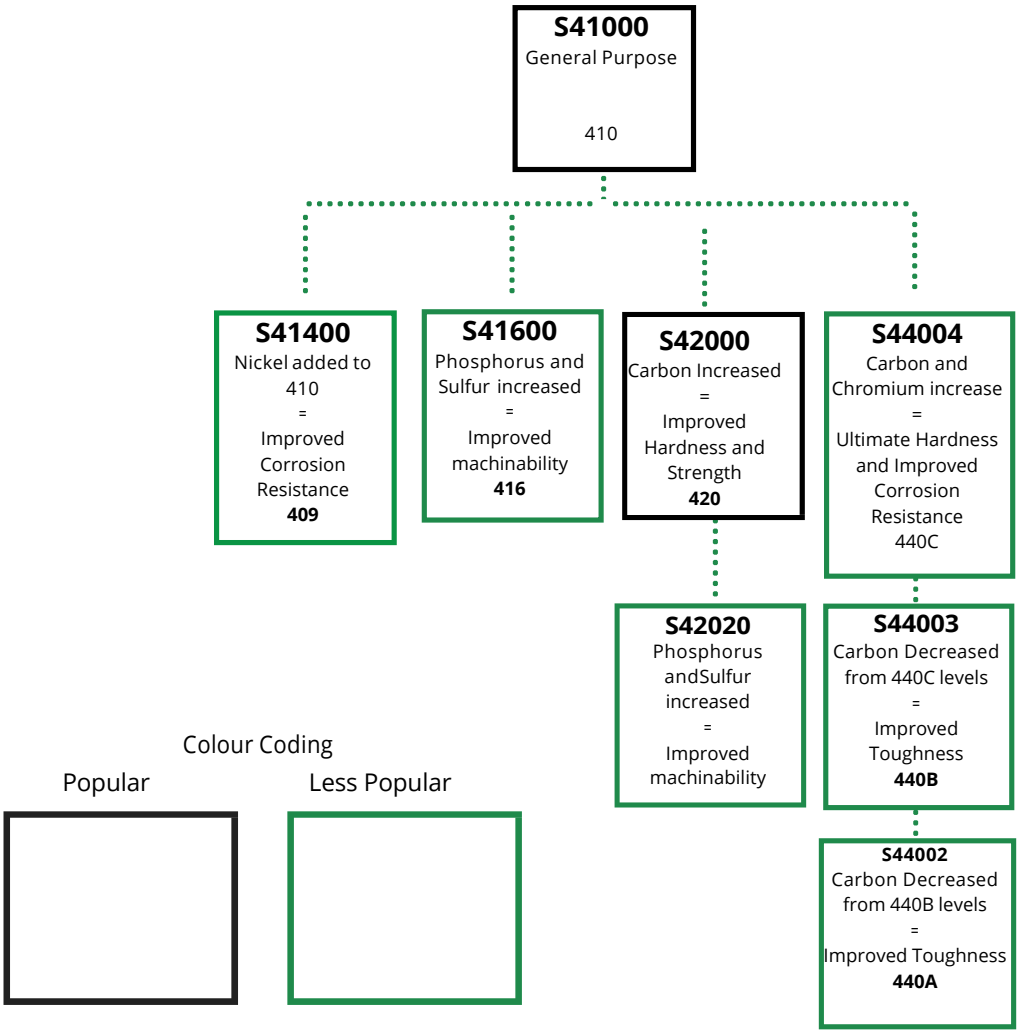
Colour Coding

Popular

Less Popular

Martensitic Chart

With such a wide variety of metal types and each having specific qualities that make them beneficial, it's important to know the different types within a metal group and the benefits, each one brings. Below are the different grades of austenitic steel. While Martensitic steel is magnetic and not ideal for highly corrosive environments, different additives can change its properties. Below are some popular Martensitic grades and the changes that give them their varying properties.



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